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# ACOUSTIC NOISE REDUCTION WITHIN THE ASW SUPPORT COMMUNICATIONS MODULES OF THE TACTICAL SUPPORT CENTER (ASCOMM/TSC)

NAVAL ELECTRONICS LABORATORY CENTER

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30 March 1976



Research and Development July 1975 to February 1976

Prepared for
NAVELEX System Engineering Center
Vallejo, California





NAVAL ELECTRONICS LABORATORY CENTER
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The ASW Support Communications (ASCOMM) portion of the Tactical Support Center (TSC) provides communication terminals during ASW aircraft missions for voice, teletype, and data transmissions in uhf, hf, and FLTSATCOM modes, both clear and encrypted. ASCOMM equipment consists of crypto equipment, remote controls, modems, patch panels, communications console, teletypes, teleprinters, reperforators, tape punches, and air conditioners. A sound survey at Naval Air Facility, Sigonella, Sicily, resulted in the NELC task reported here


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to reduce the ASCOMM noise level at all mobile ASCOMM/TSCs worldwide. NELC determined the sources and the extent of the noise problem, identified the system constraints, and designed and built equipment to minimize the noise problem with minimum interference to system operation. The equipment will be installed at NAF, Sigonella (the site which originally reported the problem) in July 1976, and before and after operational equal-level noise contours will be obtained.

## OBJECTIVE

Locate the sources of the high-level noise reported by a survey of the ASCOMM/TSC at Naval Air Facility, Sigonella, Sicily. Determine the full extent of the noise problem and identify the system constraints. Design and build equipment to minimize the problem at all mobile ASCOMM/TSCs worldwide with little interference to system operation.

## RESULTS

1. Personnel movements and actions at ASCOMM/TSC, Barbers Point, Hawaii, were observed and recorded. Noise data were obtained, and noise and vibration recordings were made for each noise source. The data were analyzed and design criteria were generated. Operating personnel were interviewed with respect to possible equipment modifications.

2. Feasibility models of the noise reduction equipment were designed and enough were built to construct one system. The system was built into a new ASCOMM installation in Misawa, Japan, and before and after noise measurements were taken which indicated satisfactory noise reduction.

3. Final versions of the equipments were designed for use as models. Assembly drawings were made and installation instructions were prepared.

4. Another set of equipment (less the air conditioner silencers) was supplied for installation in the ASCOMM/TSC, Adak, Alaska.

## RECOMMENDATION

Document the noise levels at ASCOMM/TSC, Naval Air Facility, Sigonella, before and after installation of the equipment.

## ADMINISTRATIVE INFORMATION

Work was performed under OMN, ELEX WD, X (NELC N306), by members of the Human Factors Division. This report covers work from July 1975 to February 1976 and was approved for publication 30 March 1976.

The authors express their appreciation to the TSC project personnel at NAVELEX-SYSENGCEN, Vallejo, California, for their support and guidance, and especially to A Keisel and J McCaskill for their valuable on-site support.

## CONTENTS

## BACKGROUND

There are 14 Tactical Support Centers (TSCs) around the world, designed to provide tactical assistance to ASW commanders. The ASCOMM (ASW Support Communications) portion of the system provides communication terminals during ASW aircraft missions for voice, teletype, and data transmissions in uhf, hf, and FLTSATCOM modes, both clear and encrypted. The ASCOMM equipment consists of crypto equipment, remote controls, modems, patch panels, communications console, teletypes, teleprinters, reperforators, tape punches, and air conditioners.

Naval messages from ASCOMM/TSC Naval Air Facility (NAF), Sigonella, Sicily, in November of 1973 complained of the noise level. Subsequent noise measurements by the Air Station Medical Officer in March 1974 showed that the noise ranged from 80 to 81 dBA, and the area was therefore considered to be a "Noise Hazard Area." COMNAVAIRTESTCEN, Patuxent River, Maryland (Code ST-35), in a letter dated 27 June 1974 (ser ST 35/187), proposed a detailed sound survey of the ASCOMM/TSC at NAF, Sigonella. The Naval Electronic Systems Command funded an air task/work unit to record, measure, and analyze sound levels at this site. A two-man team from Naval Air Test Center headed by Roger H Seltz performed the sound survey at NAF, Sigonella, on 14 and 15 August 1974. Measured noise levels ranged from 76 to 100 dBA for various operating conditions at various points about the ASCOMM modules. Based on these findings, NAVELEXSYSENGCEN, Vallejo, California, was requested by the Naval Electronic Systems Command (ltr COMNAVELEC-SYSCOM to COMNAVAIRSYSENGCEN, Vallejo, ser 153-51021, dated 15 April 1975) "to initiate a project to reduce the noise level in the ASCOMM/TSC modules."

The Naval Electronics Laboratory Center (NELC), Human Factors Division (Code 3400), was tasked 8 July 1975 by the NAVELEXSYSENGCEN, Vallejo, California, to reduce the ASCOMM noise level.

NELC's objectives were to determine the sources and the full extent of the noise problem, to identify the system constraints, and then to design and build equipment that would minimize the noise problem with little interference to system operation.

## WORK PROGRESSION

NELC personnel visited partially completed ASCOMM modules at Vallejo to become familiar with the layout, materials, equipment, and complexity of the system. Many questions arose as to the mode of operation such as how the printers are monitored which could limit the methods to be used to reduce the operating noise levels. It was decided, therefore, that a visit to an operational site would be necessary. ASCOMM/TSC, Barbers Point, Hawaii, was selected by NAVELEXSYSENGCEN, Vallejo, for this operational analysis because of a parallel assignment to work on this ASCOMM at that particular time.

At Barbers Point, personnel movements and actions were observed and recorded. Operating personnel were asked for their opinions of possible equipment modifications. Noise data were obtained for computer-generated equal-level contours, and noise and vibration recordings were made for each noise source. These data were analyzed at NELC, and the results were used to generate design criteria.

Feasibility models of the noise reduction equipment were designed and enough were built to construct one system. The models were taken to a new ASCOMM installation in Misawa, Japan, in August 1975. The Misawa installation was operational, but not "on the air"

when the installation and evaluation of the noise reduction equipment were initiated. A grid pattern of noise measurements (for computer generated noise contours) was obtained before and after the installation of each set of similar noise reduction equipments. The ASCOMM was placed on the air after the noise reduction equipment had been installed. The final noise grid was obtained 1 September 1975 under actual operational conditions. A follow-up phone call was made by NELC personnel from Tokyo 28 October 1975 to obtain opinions from operational personnel after extended usage of the feasibility models of the noise reduction equipment.

The feasibility models reduced the noise in the on-the-air ASCOMM/TSC, Misawa, to a maximum of 76 dBA. In October, NAVELEXSYSENGCEN, Vallejo, decided to have NELC design the final versions of the noise reduction equipment and to supply one of each final item to be used as a model during production, construction and assembly drawings, and installation instructions.

The production models were completed in February after one complete set of equipment (less the air conditioner silencers) had been supplied for installation in the ASCOMM/TSC, Adak, Alaska. The drawings were supplied as a separate package in March, and the installation instructions will be presented in forthcoming NELC technical document 471.

## FINDINGS

The ASCOMM/TSC, Barbers Point, was observed to function as follows:

Six Navy radiomen (male and female) were assigned to the system, working two at a time on an 8-hour watch. A Navy chief was the communications supervisor. A watch supervisor was also present.

The physical movements of the radiomen about the modules consisted of the following:

1. Working with the teletype equipments which are mounted from floor to ceiling in nine racks and two floor-mounted tape preparation units
2. Sitting or standing at a desk or table preparing and reading messages, using the telephone, and talking to other personnel that require assistance
3. Working on the crypto equipment racks to change the key list
4. Walking to the door to accept messages
5. Walking out of the ASCOMM area to deliver messages
6. Working at the console when messages are being received and transmitted by voice
7. Working at the patch and test facility when system problems arise

While the radiomen perform all the above tasks, they monitor up to 14 radio circuits with the corresponding loudspeakers mounted on two panels of a console and at station 14X RCVR/KEYER. (See fig 1.) Each of the 14 circuits has volume controls and the 12 circuits in the console have VOX slow-release light indicator switches. Two handsets (one for red and one for black circuits) are provided for two-way communication over these circuits. In order for personnel to hear these signals above the ambient noise at the various sections of the system in which they might be walking, the loudspeaker volumes are turned up high. (At this high volume, the atmospheric noises in the radio circuits become a significant part of the ambient noise.) The two loudspeakers at station 14X are meant to be used only as a monitor

while the corresponding receiver at station 14X is being adjusted, but for various personal reasons these speakers are turned up as high as 100 dB.*

In order to attain an overall picture of the noise problem in the ASCOMM, Barbers Point, noise data were obtained as inputs for computer-generated equal-level contours of the A-weighted noise levels and Speech Interference Levels (SILs). These contours are shown in figures 1 and 2, respectively. The highest measured noise level was 85 dBA in figure 1. This level is below the BuMed** specified maximum allowable noise level of 90 dBA for 8-hour exposure, but it could still be harmful to the hearing of 20% of the ASCOMM personnel. The SIL is an indicator of the degradation of face-to-face speech communications, as shown in figure 3. The ordinate in figure 3 represents the distance between talkers and the abscissa represents the SIL. At 72-dB SIL, which is representativeof the level between the console and teletype equipment racks, it is necessary that personnel be no more than 1½ feet apart for normal conversation or 2½ feet apart for communicating voice levels. Even though it is usually possible for the ASCOMM personnel to come within these distances of each other, it sometimes requires one person to leave his work station, or causes vital time to be lost in response to an emergency situation. Difficulty in telephone communication is another problem at 72-dB SIL.

The major sources of noise in the ASCOMM were considered to be the following:

1. Loudspeaker-generated sounds
2. Reperforators
3. Printers
4. Teletypes
5. Air conditioners

In order to investigate these noise sources in detail, tape recordings were made of the acoustic noise and the vibrations produced by one TT-605/UG reperforator, one AN/UGR-9 printer, one AN/UGC-77 teletype, and one air conditioner.*** The recordings were analyzed at NELC. The analysis of the recordings generated the following information:

1. The combination of the built-in vibration isolators and the sliding shelves that hold the reperforators, teleprinters, and teletypes provides vibration isolation from the racks in the order of 10:1; therefore, additional vibration isolation is not necessary.
2. The octave band spectra of the noise measured 1 foot in front of the reperforator, printer, teletype, and air conditioner while each was in full operation are shown in table 1. The A-weighted levels of the reperforator and the printer are almost the same even though their octave band spectra differ. The operating cycle of these two equipments is long; therefore, they both require noise reduction. The teletype, however, does not have a long operating cycle, so even though its overall sound level during constant operation is actually slightly higher than those of the reperforator and the printer, it does not require noise reduction.

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*ASCOMM/TSC sound survey; by NAVAIRTESTCEN (Code ST-35) ltr Aug 1974

**BUMED INSTRUCTION 6260.6B, Hearing Conservation Program, 5 March 1970

***ASCOMM/TSC, Barbers Point, is a working system; therefore, even though the ambient noise was made low as possible, these tape recordings contained some significant background noise that masked part of the noise being analyzed.

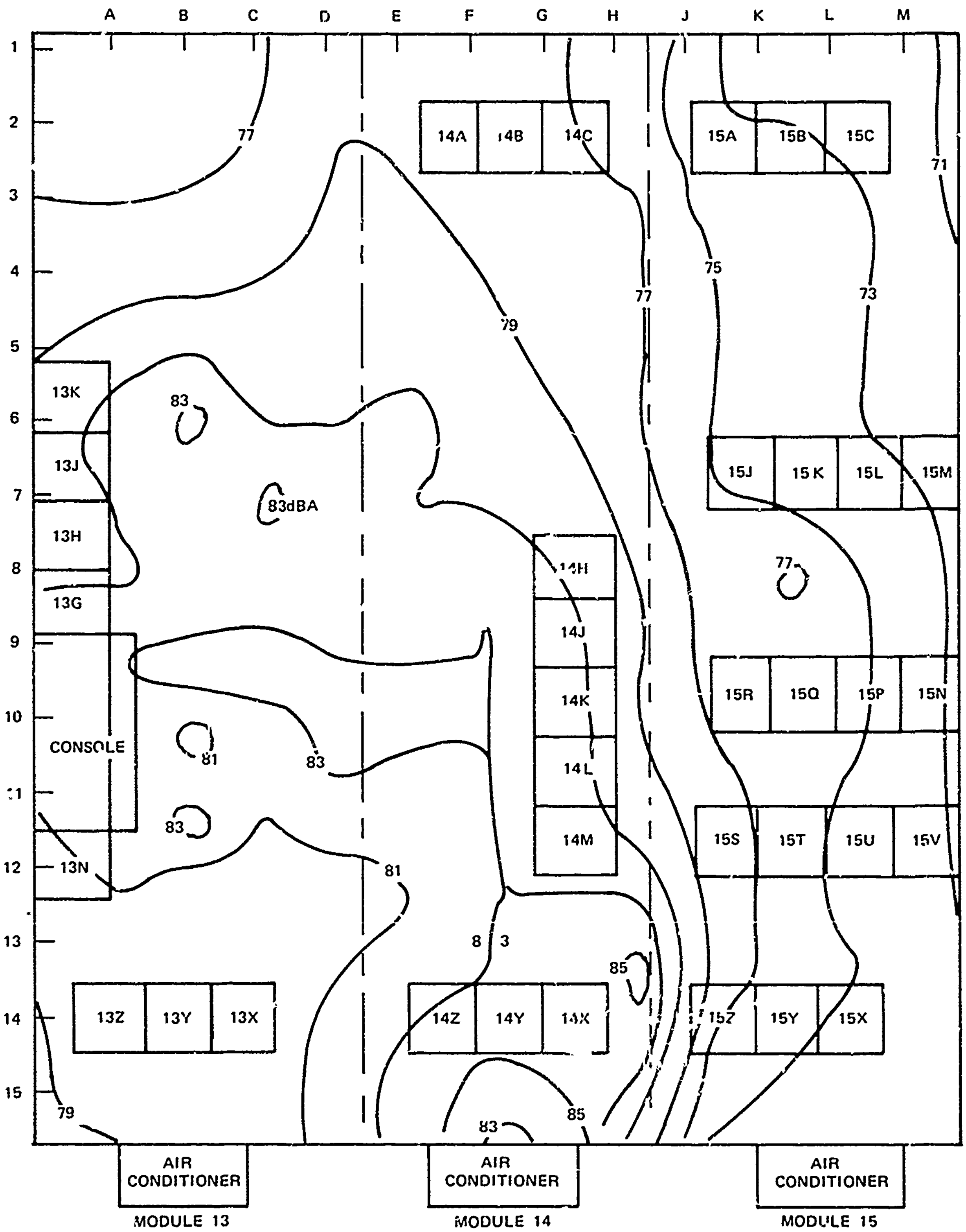



Figure 1. A-weighted equal-level noise contours, ASCOMM/TSC, Barbers Point, Hawaii, for operational system.

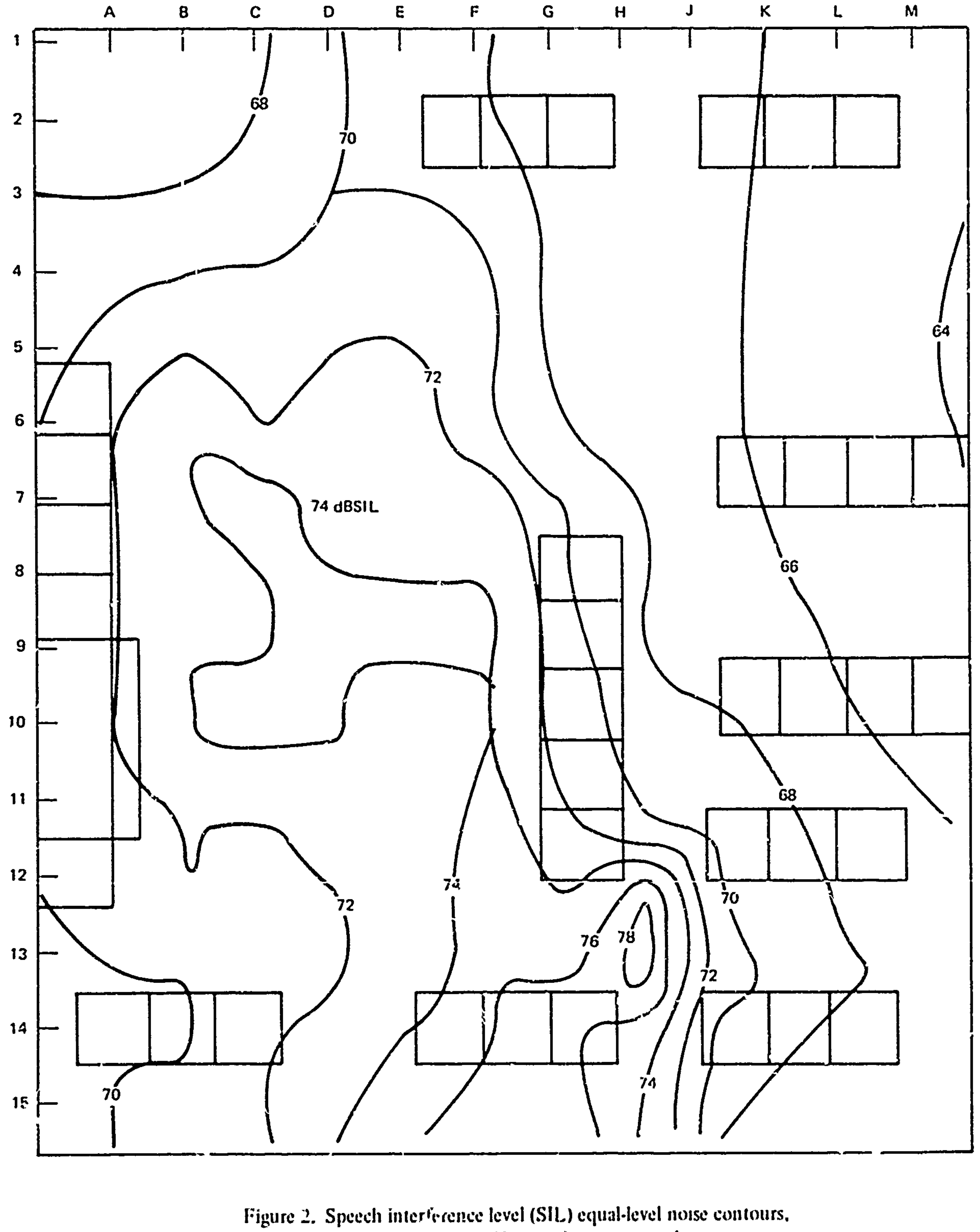



Figure 2. Speech interference level (SIL) equal-level noise contours, ASCOMM/TSC, Barbers Point, Hawaii, for operational system.

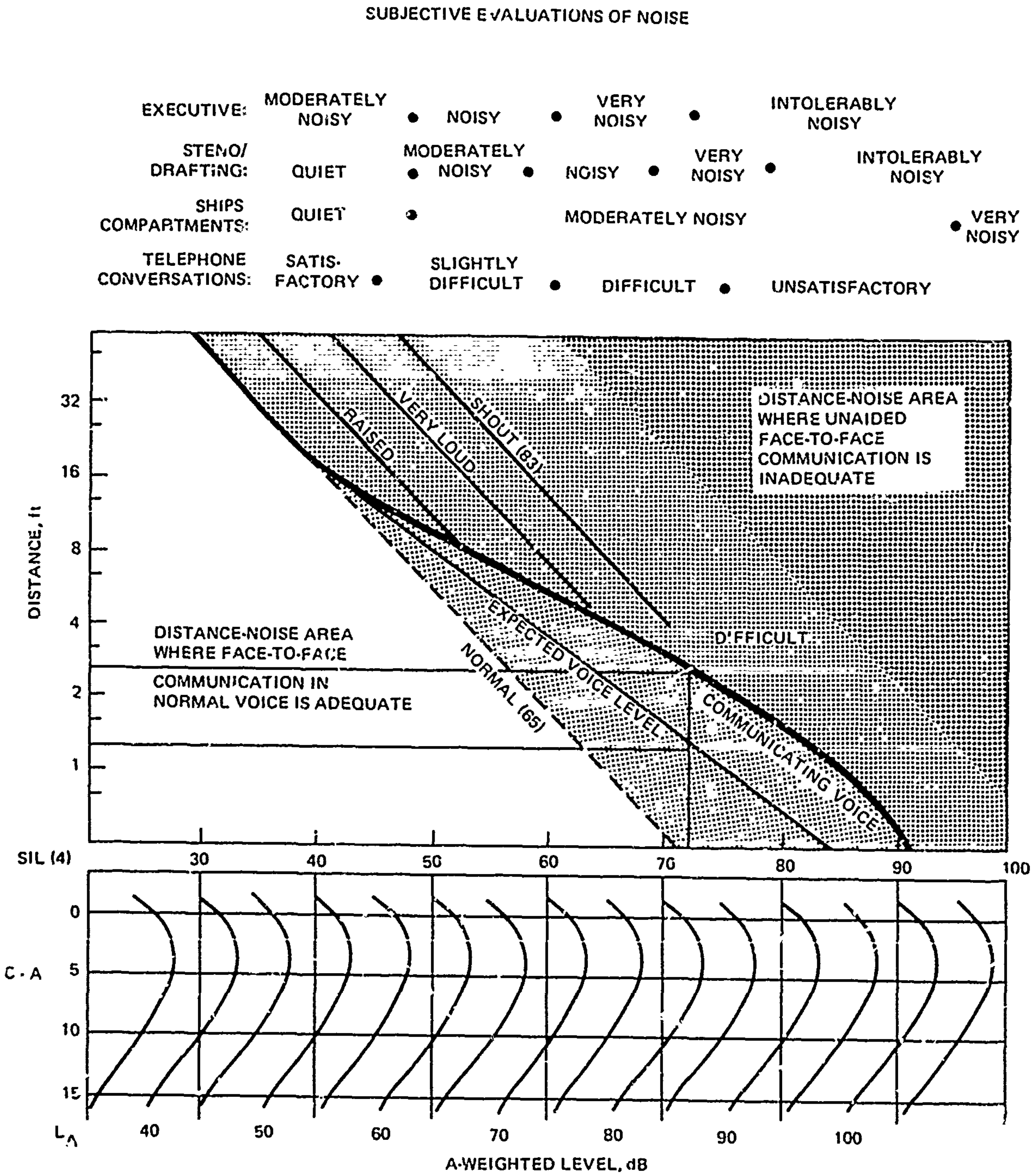



Figure 3. Permissible distance between a speaker and listeners for specified voice levels and ambient noise levels. (1 ft = 0.3048 meter.)

The ceiling structure in each module consists of perforated metal sections (1 by 2 feet with 6% open area) with an insert of a sheet of heavy treated paper topped by a 1-by-2-foot piece of stiff thermal foam. This had been considered to be an acoustic ceiling, but in fact the absorption coefficient of the structure was only 0.20 (acoustic tile averages about 0.65 and acoustic foam about 0.80). Acoustical absorption by a ceiling attenuates the overall noise and also gives a relatively pleasant sensation to the remaining noise.

The A-weighted level of the air conditioner is 72 dB at the intake (the noise spectrum is shown in table 1), which is a low level compared to the present ambient noise levels shown in figure 1. However, the operational cycle of the air conditioner is long, and the new ambient levels after noise treatment will probably be close to 72 dBA. This means that if the noise from the air conditioners is not reduced, the effectiveness of all other noise treatments could be limited by the air conditioner noise.

TABLE 1. NOISE SPECTRA* OF ASCOMM/TSC EQUIPMENT.

| Description | | | Octave Band Center Frequency, Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| | dBA | dBC | dB | dB | dB | dB | dB | dB | dB | dB | dB | dB |
| TT605/UG reperforator | 82 | 81 | ** | ** | 61 | 69 | 68 | 72 | 73 | 79 | 77 | 64 |
| AN/UGR-9 printer | 81 | 80 | 70 | 64 | 62 | 63 | 63 | 72 | 75 | 76 | 76 | 65 |
| AN/UGC-77 teletype set | 83 | 82 | 72 | 72 | 66 | 68 | 67.5 | 73.5 | 74.5 | 76.5 | 77.5 | 65.5 |
| Air conditioner (at intake) | 72 | 81 | 77 | 74 | 76 | 72 | 65 | 66 | 66 | 61 | 52 | ** |

*All levels are corrected for ambient noise.
**Could not be measured because of level of ambient noise.

## FEASIBILITY MODELS

The next phase of the project was to design noise reduction equipment that would considerably lower the ambient noise level without affecting the operation of the ASCOMM, and then to build feasibility models for one complete system. At the onset of the design phase, it was decided to design a shelf barrier for the reperforator, a cover for the printers, and a silencer for the air conditioners, to redesign the console loudspeaker system, and to improve the absorption coefficient of the ceiling.

### LOUDSPEAKER SYSTEM

In order to avoid operational changes in the use of the console while minimizing the noise generated in the area of the console, it was decided to abandon the concept of a separate loudspeaker for each receiver circuit. The signals from the 12 receivers would be mixed together, amplified, and distributed over ceiling loudspeakers throughout the three ASCOMM modules. The signals would be obtained from the leads taken off each receiver loudspeaker, therefore, the level controls and the light indicator switches would continue to operate as they did before modification of the loudspeaker system. A VU meter would be put in the place of

each console loudspeaker for a visual indication of the circuit signal level. Each ceiling loudspeaker was provided with a "T" pad level control. Figure 4 is a block diagram of the feasibility model of the loudspeaker system.

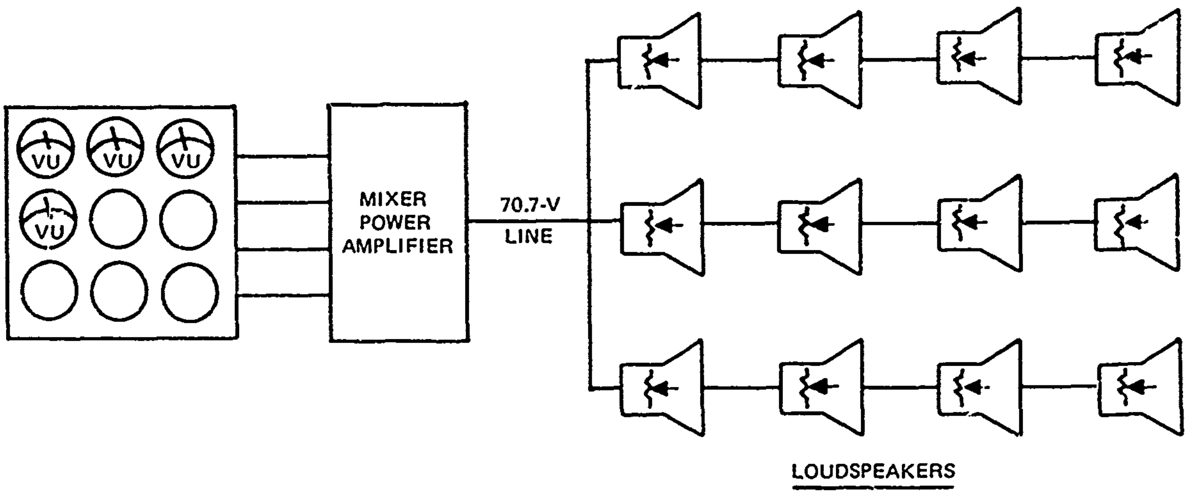



Figure 4. Block diagram of feasibility model of loudspeaker system.

## REPERFORATOR

The TT605/UG reperforators are placed in the centers of the top shelves of the teletype racks. Three power supplies are mounted on an unvented panel at the rear of each rack in back of the reperforators. Acoustical foam lines the inside of the racks. (Older ASCOMMs that do not have foam lining in the racks should be so lined during the installation of noise reduction equipment.)

The reperforator cover has large open areas for air circulation, therefore, it was decided not to reduce its noise output by modifying or adding to the cover. Instead, it was decided to use a barrier on the front end of the shelf to reflect the noise back into the rack. This barrier would reduce the air flow to the reperforator. In order to maintain sufficient air flow, the panel that supports the power supplies was vented to provide air flow through the door vent at the rear of the rack.

The front barrier panel was made with a door to minimize interference with servicing and maintenance. An enclosed curved slot was provided for the paper tape feed. Existing holes in the side lip were used in mounting this panel to the sliding shelf.

## PRINTER

The AN/UGR-9 printers are mounted two shelves below the reperforators with the AN/UGC-77 teletype sets mounted on the shelves in between. During ASCOMM operations, the printers are occasionally rolled out beyond the rack so that the radiomen can read the message being printed. This means that optimum noise reduction would be realized by an improved cover which would reduce the noise while the printer was inside or outside the rack. The air vents in the printer cover are comparatively small, therefore, it is possible to make a better attenuating cover without restricting the air flow.

For the feasibility models which had to be constructed in only a few weeks, it was decided to make a fabric shell to go over the existing cover. This shell was made of special noise attenuating fabric ("Alphalon"), cut and sewn to fit snugly over the existing cover, with 1/8-inch-thick neoprene sponge spacers in between to improve the effectiveness of the fabric. A flap was provided to allow for paper servicing of the printer. The clear plastic panel in front of the paper feed was replaced by a double piece of clear plastic with an air gap in between.

## AIR CONDITIONER

One air conditioner is mounted on the end wall of each of the three ASCOMM modules, as shown in figure 1. The return air enters an air conditioner through two grills and two replaceable air filters, which are located about 4 feet above the floor. The exhaust air exits through the top of the air conditioner into the area between the dropped ceiling and the roof. This air is trapped by small air scoops in the dropped ceiling which distribute the conditioned air throughout the ASCOMM.

No significant noise was measured as coming from the air conditioner exhausts The A-weighted noise at the intake to the air conditioner was 72 dB. A silencer was designed to attach to the wall by use of the screw holes that held the existing intake grill. The filter would remain where it was and could be serviced by removing the front of the silencer, which is held in place by four screws.

## CEILING FOAM

Since the conditioned air flows above the "acoustical" ceiling, it is necessary to maintain this ceiling as a thermal insulating layer. Therefore, an acoustical foam with a high thermal K factor was selected. Conaflex A-FR-100, 1 inch thick,* has a high thermal factor and gives an absorption coefficient of 0.63 when used in conjunction with the existing perforated (6% open area) metal ceiling. If the ceiling pieces were 20% open, the absorption coefficient would be close to 0.80. This additional absorption would reduce the noise approximately an additional 1 dB. The replacement of the perforated metal sections was not considered to be cost-effective and so was not implemented. Therefore, only the existing thermal foam and treated paper were eliminated and replaced by the Conaflex A-FR-100 foam.

*1 inch = 25.4 mm

## INSTALLATION AND EVALUATION OF FEASIBILITY MODELS

The feasibility models of the noise reduction equipment were evaluated in a newly installed ASCOMM/TSC in Misawa, Japan, just before the ASCOMM was placed on the air. Two NELC personnel and one senior technician and two contractor personnel from NAVELEXSYSENGCEN, Vallejo, installed and adjusted the noise reduction equipment. The NAVELEXSYSENGCEN personnel set up the ASCOMM to simulate on-the-air conditions while the NELC personnel performed the evaluations.

## NOISE CONTOURS

Noise measurements to be used for computer generation of equal-level contours, in A-weighted sound level and in SIL, were taken under the following sequential conditions:

| | |
|---|---|
| 21 August | No acoustic treatment |
| 22 August | Acoustic foam in ceiling |
| 23 August | 12 loudspeakers to replace 4 on console* |
| 24 August | Covers on printers and reperforators, and temporary barrier panel in the ARC-143 rack to block sound path** |
| 25 August | Silencers added to air conditioners |
| 1 September | Operational system with one additional printer and reperforator running full time (shelf extender on ARC-143 had been removed) |

The corresponding noise contours are shown in figures 5 through 10.

Some noise reduction is apparent for each feasibility model installed. The shape of the contours changes each time because of the effects of direct and reverberated noise and the location of the feasibility models. Therefore, it is not possible to give an accurate numerical representation of the total amount of noise reduction achieved throughout the system, but an approximation of the effect on the personnel as they move about the ASCOMM will be made for summary purposes.

The addition of the acoustic foam to the ceiling (compare fig 5 and 6) reduced the A-weighted noise 1–3 dB and the SIL 3–6 dB. The maximum effectiveness of the foam is noticed some distance from the noise sources, since the ceiling treatment reduces mostly reverberant noise. The placement of the 12 loudspeakers on the ceiling throughout the ASCOMM (compare fig 6 and 7) accounted for a 1–4-dB drop in both the A-weighted and the SIL levels. This improvement was noticed mostly right in front of the console, where the original loudspeakers radiated. The covers on the printers and the barriers on the reperforators and in the ARC-143 rack (compare fig 7 and 8) resulted in an A-weighted noise reduction of 4–6 dB and SIL reduction of 2–4 dB.

*Only 4 out of the 12 possible channels were in use.

**The noise from the ARC-143 rack was not noticeable in the high ambient noise of ASCOMM/TSC, Barbers Point, but it was quite prominent after the acoustic treatment. The barrier panel served to reflect the noise away from the area occupied by the ASCOMM personnel.

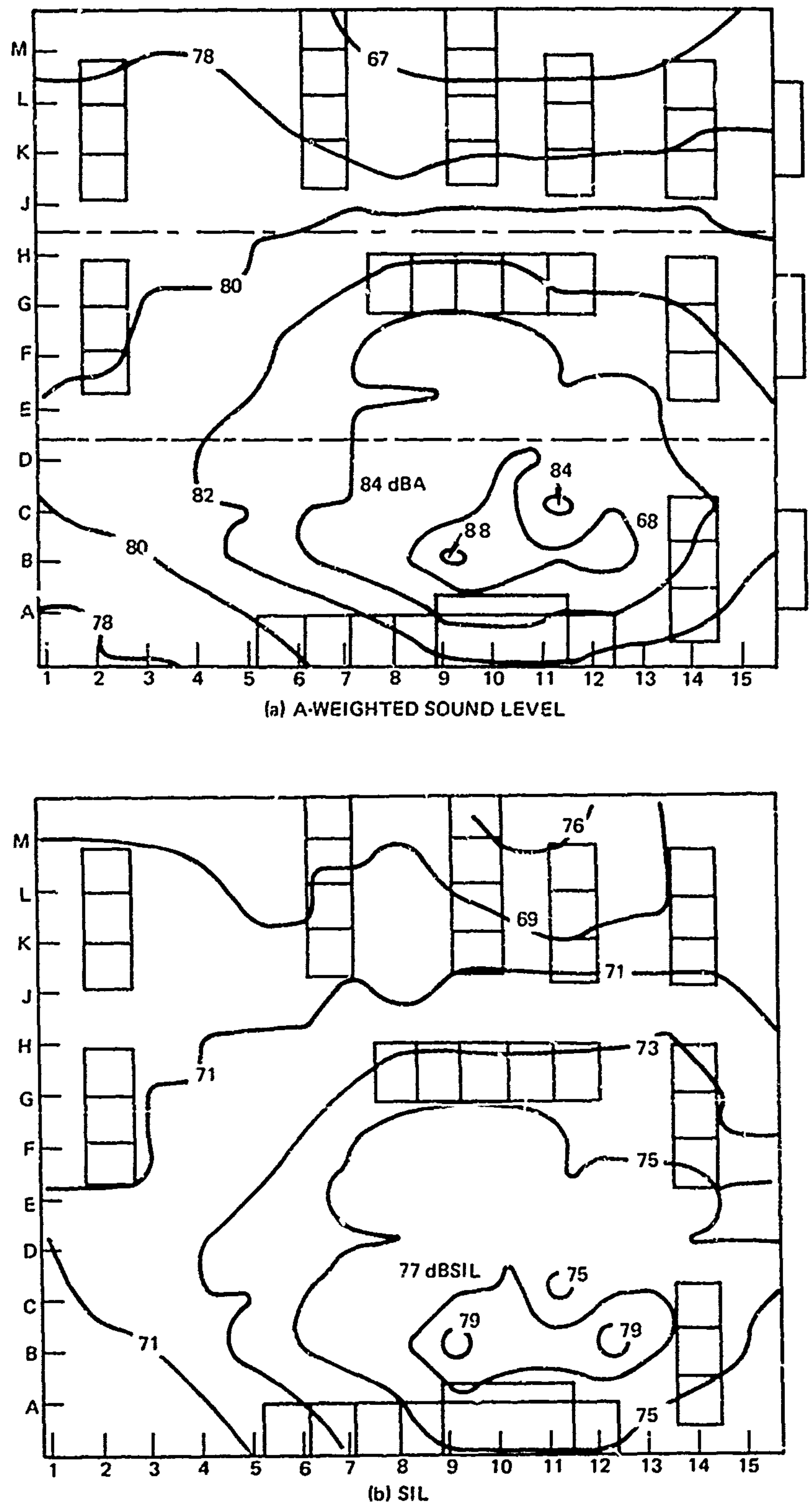
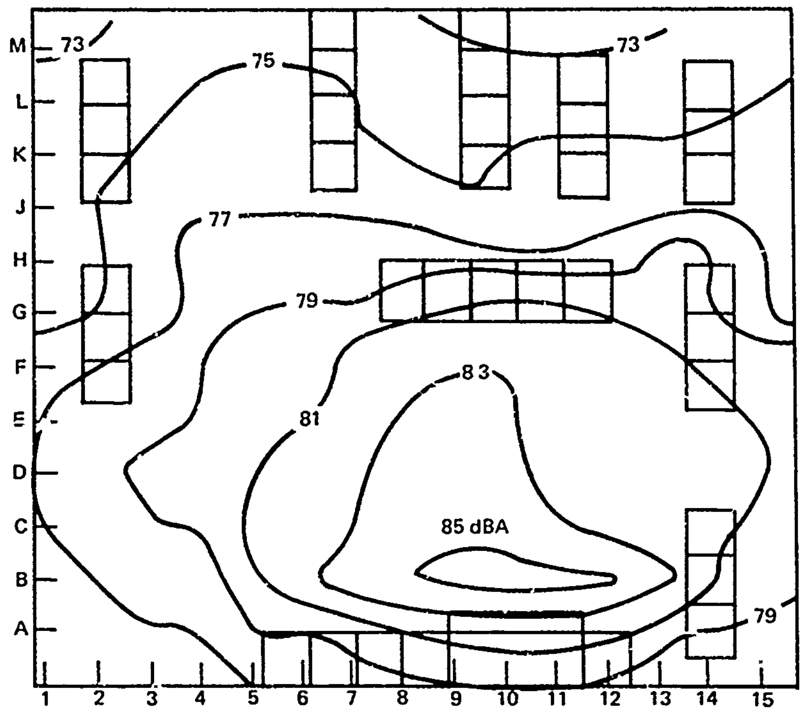
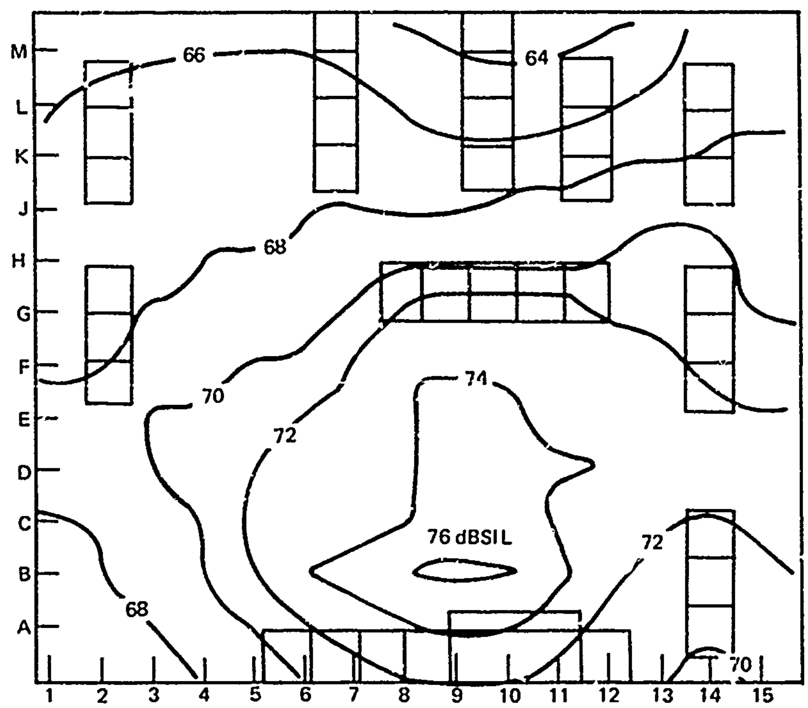



Figure 5. Equal-level noise contour, ASCOMM/TSC, Misawa, Japan; simulated operation, no noise reduction treatment.




(a) A-WEIGHTED SOUND LEVEL




(b) SIL

Figure 6. Equal-level noise contour, ASCOMM/TSC, Misawa, Japan; simulated operation, ceiling foam pads installed.

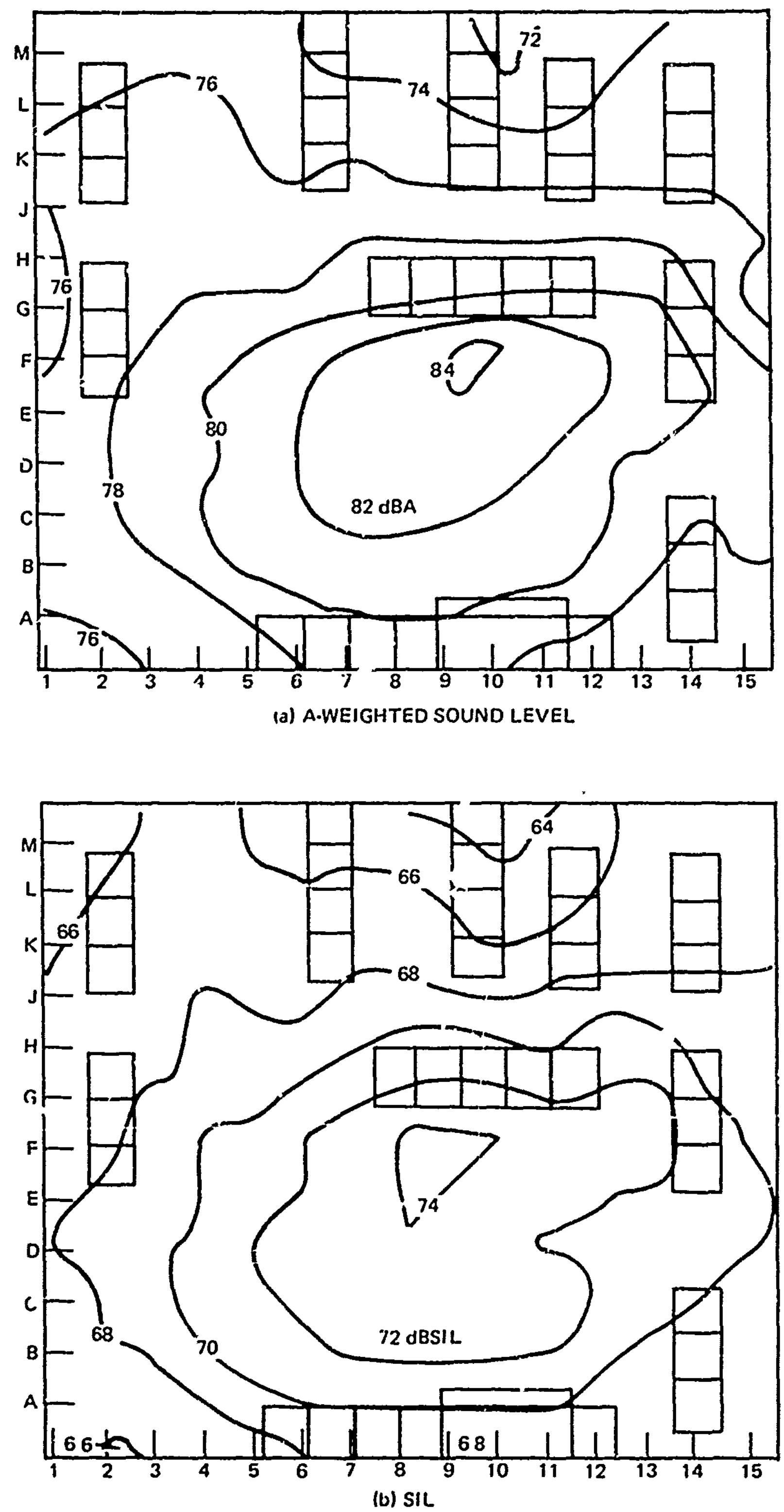



Figure 7. Equal-level noise contour, ASCOMM/TSC, Misawa, Japan; simulated operation, feasibility model loudspeaker system installed.

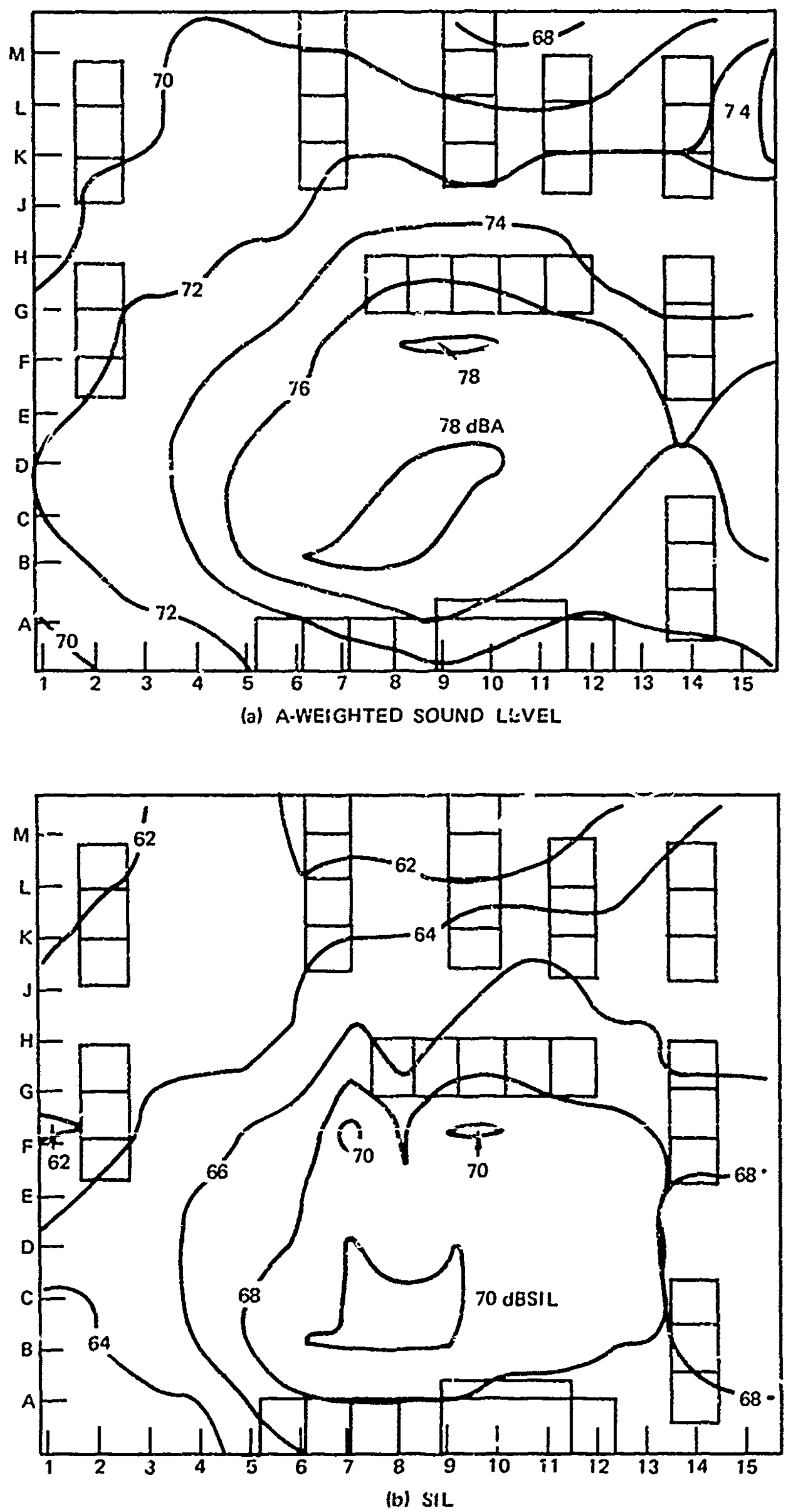
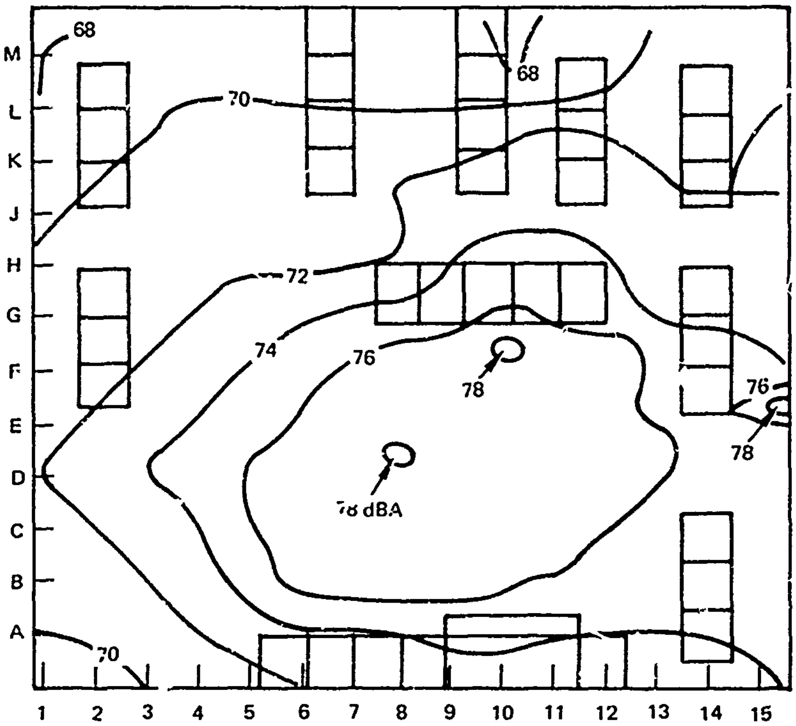



Figure 8. Equal-level noise contour, ASCOMM/TSC, Misawa, Japan; simulated operation, feasibility model barrier panels installed.

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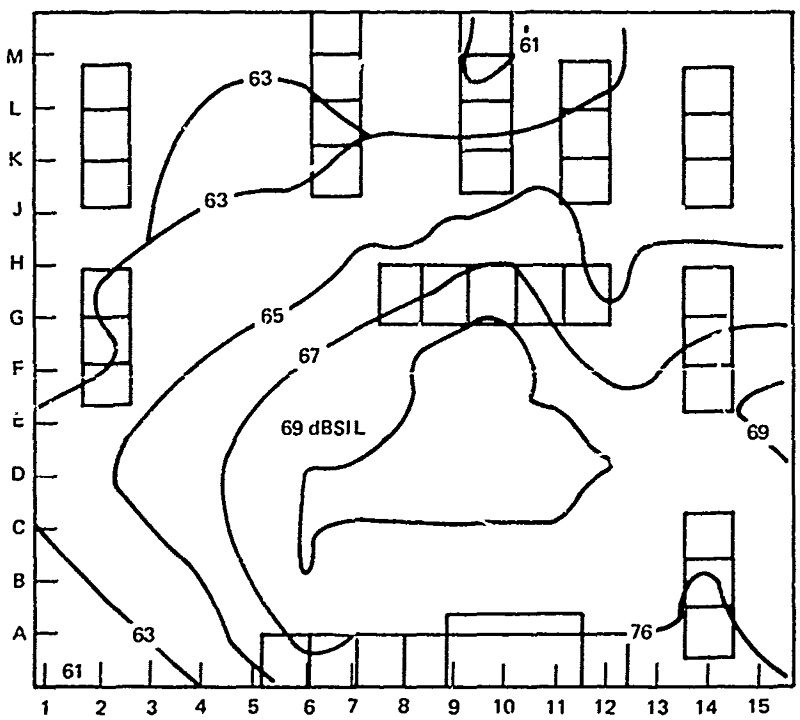
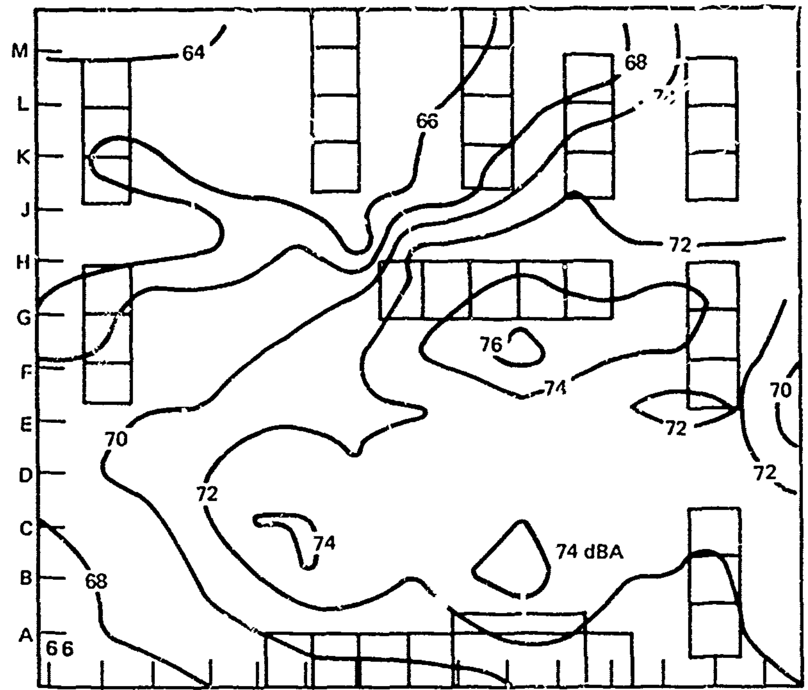
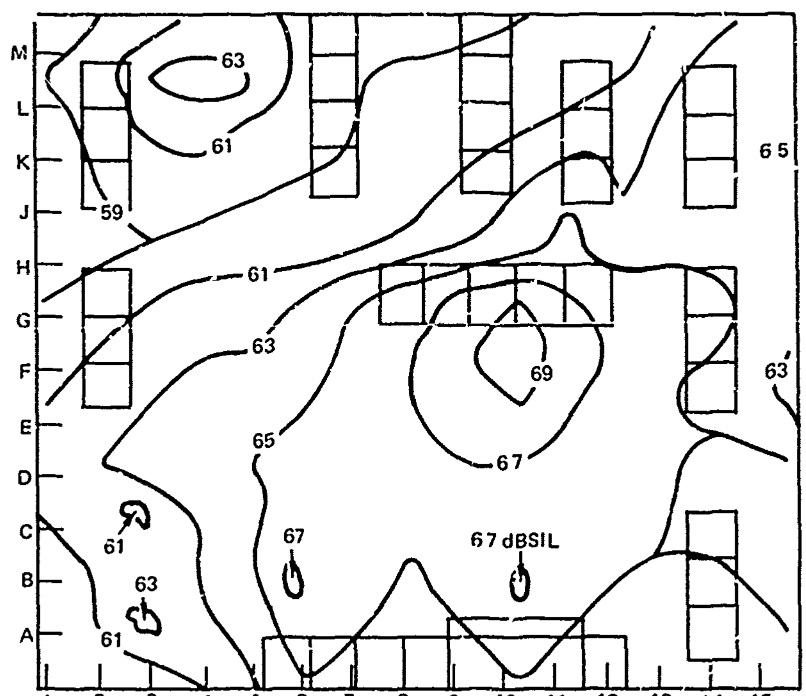



(b) SIL

Figure 9. Equal-level noise contour, ASCOMM/TSC, Misawa, Japan; simulated operation, feasibility model air conditioner silencers installed.




(a) A-WEIGHTED SOUND LEVEL




(b) SIL

Figure 10. Equal-level noise contour, ASCOMM/TSC, Misawa, Japan: operational system with all feasibility models installed.

By comparing figures 8 and 9, it can be seen that the air conditioner silencers reduced the A-weighted noise by 0–1 dB and the SIL by 1–2 dB. These silencers made the least amount of difference in the overall noise, but the minimum noise level is limited by the air conditioner noise. (The air conditioner near the console was the noisiest of the three, and most of this noise was being radiated by the wall and not coming through the intake. Therefore, any further noise reduction would have to include treatment of the air conditioner walls.)

By comparing figures 5 and 9, it can be seen that the total noise reduction for all the feasibility models is approximately 7–10 dB A-weighted and 6–11 dB SIL. The noise levels in the operational ASCOMM/TSC, Misawa, compared to the operational ASCOMM/TSC, Barbers Point (compare fig 10 with fig 1 and 2), were less by 7–9 dB A-weighted and 5–7 dB SIL. These two ASCOMMs were not set up identically with respect to furniture and equipment operating during noise measurements, but the noise reduction in Misawa is significant. The differences would be even greater in the area of the console during radio reception of voice.

## INDIVIDUAL MODEL ANALYSIS

The noise reduction of the individual feasibility models including the ARC-143 barrier panel was evaluated at a 1-foot distance by taking A- and C-weighted and octave band noise levels and tape recordings of each equipment being treated before and after the installation of the feasibility models. (The effectiveness of the distributed loudspeaker system is best shown by the noise contours, so no detailed analysis was performed on this installation.) A narrowband analysis of the tape recordings showed that there are no sharp peaks in the noise spectra to create personnel discomfort or annoyance.

Table 2 shows the noise reduction of each feasibility model in A- and C-weighted and octave band levels. One of the reperforator barrier panels was modified to fit the printer shelf. The noise reduction of this barrier on the unmodified printer is also shown in table 2. This barrier, compared to the printer cover, gave better noise reduction in three out of the four SIL bands.

TABLE 2. NOISE REDUCTION OF FEASIBILITY MODELS.

| Description | | | Octave Band Center Frequency, Hz | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| | | | | | | SIL BANDS | | | | |
| | dBA | dBC | dB | dB | dB | dB | dB | dB | dB | dB |
| Reperforator barrier panel | 8 | 6 | 0 | 0 | 0 | 4 | 11 | 12 | 8.5 | 11 |
| Printer cover | 5 | 6.5 | 5 | 5 | 8 | 7 | 3.5 | 4.5 | 3.5 | 5.5 |
| Printer barrier panel | 8.5 | 8 | 1 | 6.5 | 2.5 | 4.5 | 8 | 7 | 10.5 | 10 |
| ARC-143 barrier panel | 7.5 | >4.5 | 0 | -3.5 | 0 | 5 | 9.5 | 8 | 9.5 | >4.5 |
| Air conditioner silencer | 1.5 | 0 | 0 | -0.5 | -1.5 | 2 | 2.5 | 4.5 | >2.5 | – |

## FINAL DESIGN

The design of the prototype equipment was based on the feasibility models and the data collected in the ASCOMM/TSC, Misawa.

### LOUDSPEAKER SYSTEM

The prototype loudspeaker system is similar to the feasibility model except that the reliability has been increased and all 12 receiver circuits have been mixed.

One amplifier was used to power the ceiling loudspeakers in Misawa. Since all the receiver circuits are mixed together in this amplifier, voice reception is completely lost if it fails. Therefore, two 10-watt solid-state amplifiers, each receiving all 12 receiver circuits, have been used to power two different sets of ceiling loudspeakers in the prototype system, providing a tenfold increase in reliability. As shown in figure 11, one amplifier drives four loudspeakers in module 13 and the other amplifier drives six loudspeakers divided between modules 14 and 15. In this way, the area between the console and the teletype equipment is covered by both sets of loudspeakers, and it would immediately be obvious whenever one amplifier malfunctioned. If the loudspeakers associated with each amplifier were interspersed, an amplifier malfunction might go undetected.

Sophisticated mixing circuits were not required to mix the 12 receiver circuits, because each receiver circuit has its own volume control. A simple resistive network provides mixing of receiver circuits and 120-dB isolation between them.

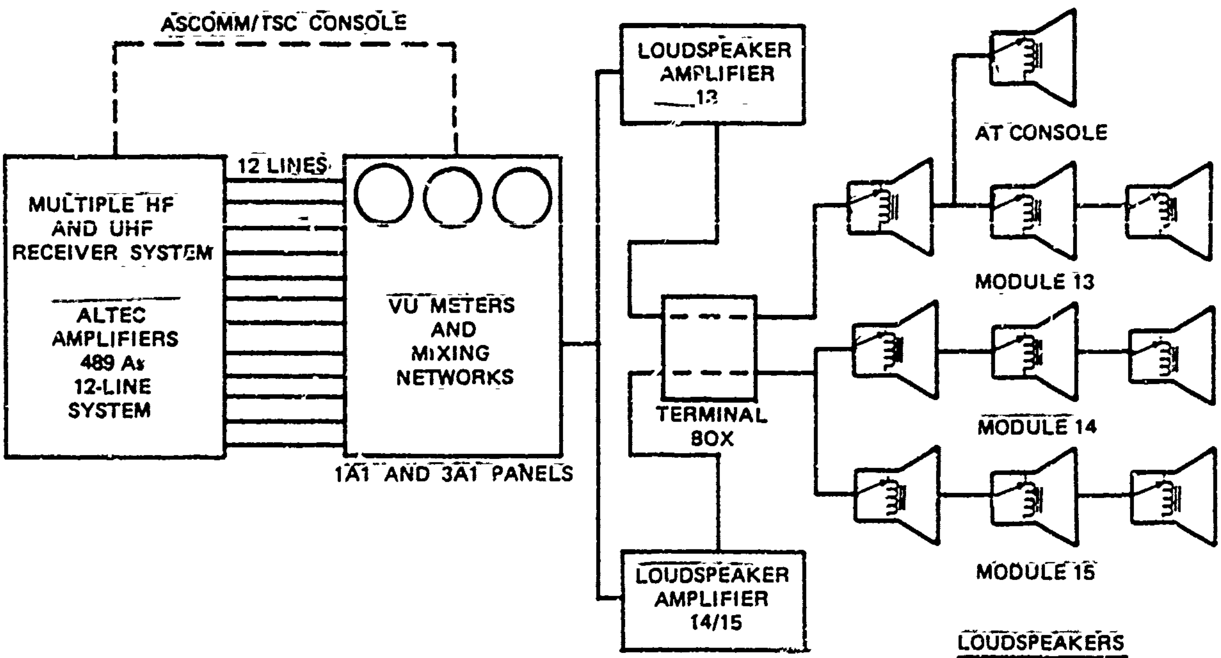



Figure 11. Block diagram of prototype loudspeaker system.

A calibrated VU meter monitors the output level of each receiver circuit at the input to the mixing network.

The ceiling loudspeaker assemblies consist of a high-efficiency 8-inch speaker, a 70.7-volt line transformer, a five-position autotransformer-switch assembly with 2-dB/step level control (with no off position), and an enclosure which is made to be mounted on the inside of one section of the perforated metal ceiling. The dispersion angle of the loudspeaker through the ceiling is 140 degrees for 6-dB level variation. Ten of these loudspeakers give uniform coverage throughout the module, with one extra speaker above the console. The 2-dB/step level control allows the radiomen to adjust the loudspeaker levels for maximum intelligibility and comfort but not to blast or shut off the system. Photographs of the parts of this loudspeaker system are given in figure 12. Photograph file numbers are indicated.

## REPERFORATOR

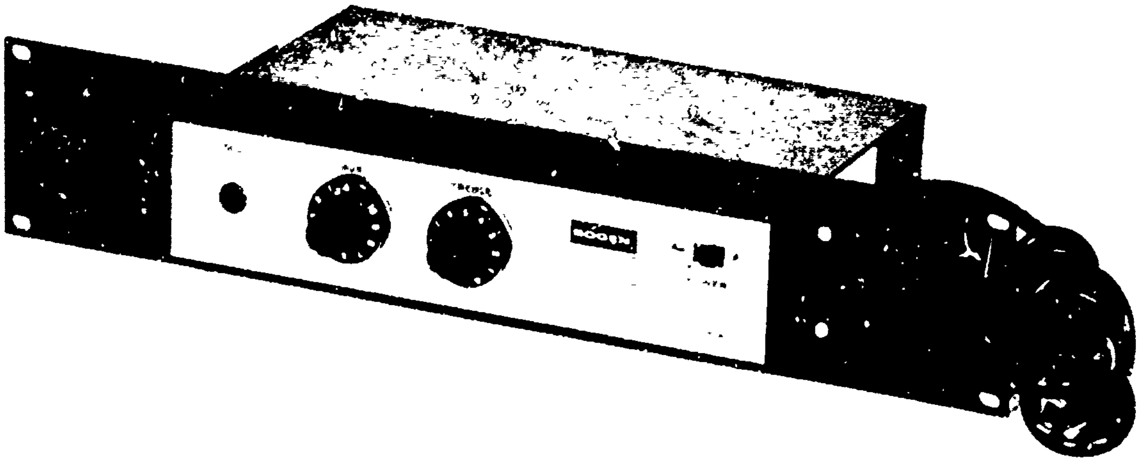
The feasibility model of the reperforator barrier panel gave sufficient noise reduction and was convenient to use. The panel was something of an annoyance during maintenance, but since it did not actually hamper maintenance, the basic design was not changed. The alignment of the tape exit port of the reperforator with the tape exit tube on the panel was affected by the lack of vibration isolators on some reperforators and the variability of the reperforator placement on the shelf. Therefore, it was decided to use an adjustable tape feed tube. The feasibility model was made mostly of Plexiglas, which would probably not stand up to "normal" use. Therefore, the prototype was made of aluminum and Plexiglas. The vented power supply panel used in the feasibility models at the rear of the reperforator provided the necessary air flow, and so it has been used as part of the prototype system. A photograph of the prototype reperforator barrier panel and the power supply panel is shown in figure 13.

## PRINTER

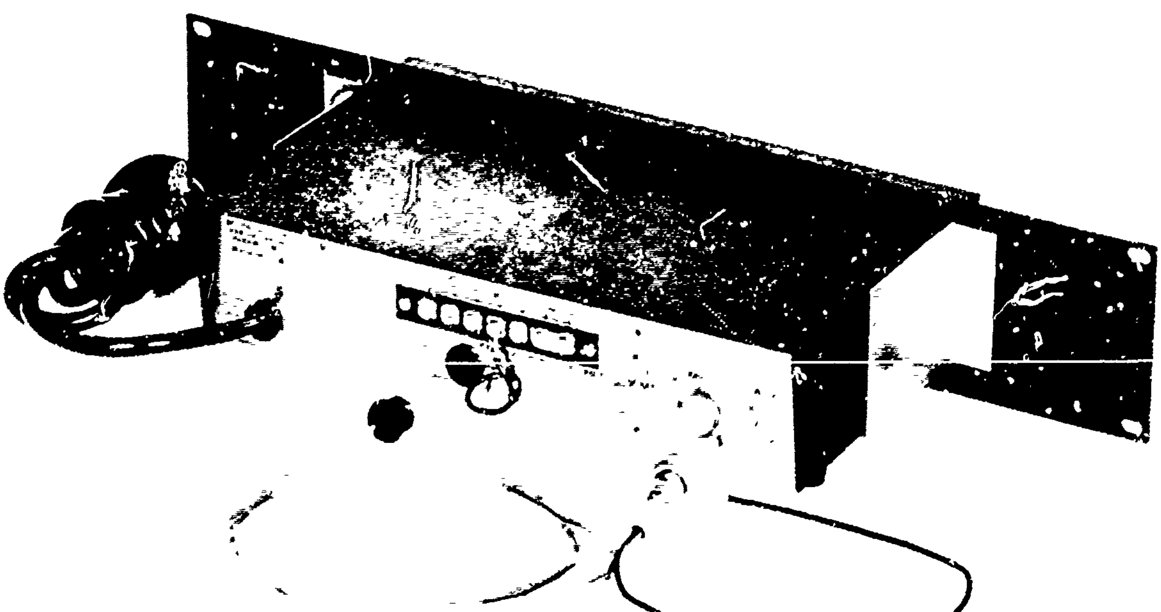
The special fabric secondary cover used on the printer for the feasibility model gave adequate attenuation, but was used just to indicate what to expect if the existing cover were improved upon. A new printer cover would be expensive to design and build because of the intricate nature of the printer design and heat flow requirements. Since the barrier panel attenuated the printer noise even better than the secondary cover did, it was decided to design a simple barrier panel for the printer. A photograph of this barrier panel is shown in figure 14. This panel will not reduce the printer noise while the printer is extended outside the rack as it was sometimes used in the ASCOMM, Barbers Point. If printers extending outside the rack remain a noise problem, then a special cover or secondary cover will have to be designed for these few printers.

## ARC-143 RECEIVER RACK

The temporary barrier panel placed inside the ARC-143 receiver rack in ASCOMM, Misawa, reduced the noise that was coming into the area where the personnel work and so a prototype barrier panel was designed. This panel is to attach to the inner rack mounting angles and incorporates the two threaded plates used to hold the receiver shelf in a vertical position. A photograph of this barrier panel is shown in figure 15.

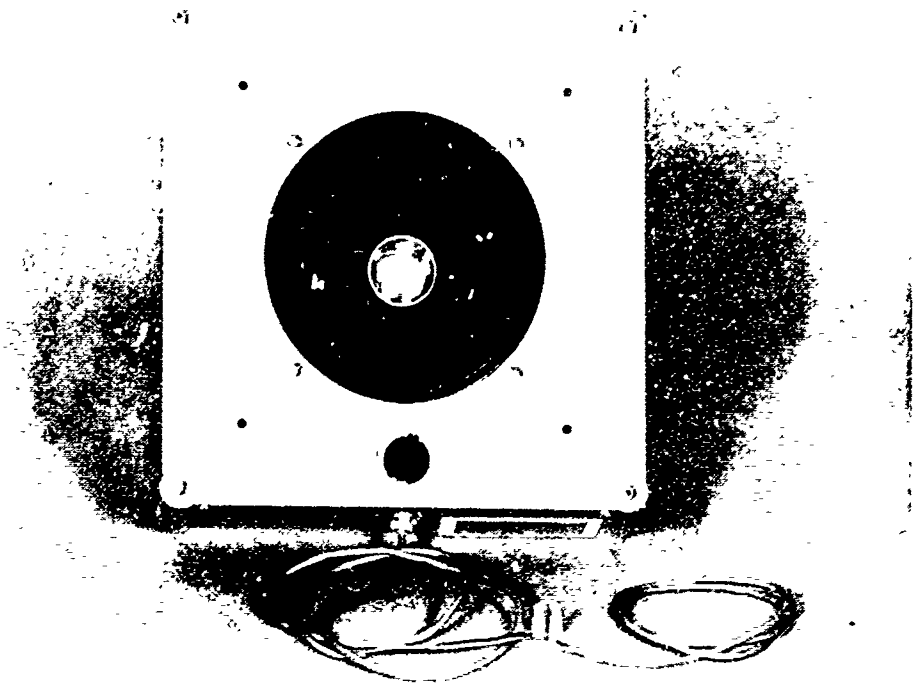


(a) FRONT VIEW (LSF 343-2-76)

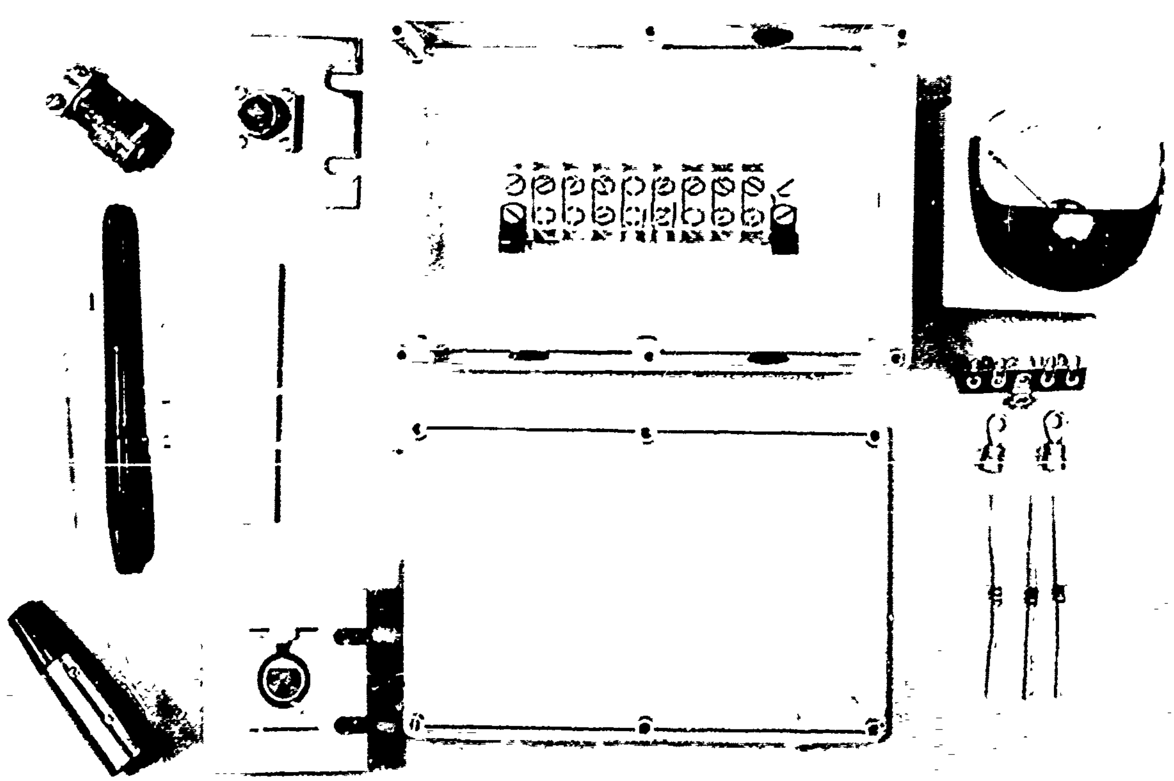


(b) REAR VIEW (LSF 344-2-76)

Figure 12. Loudspeaker amplifier.

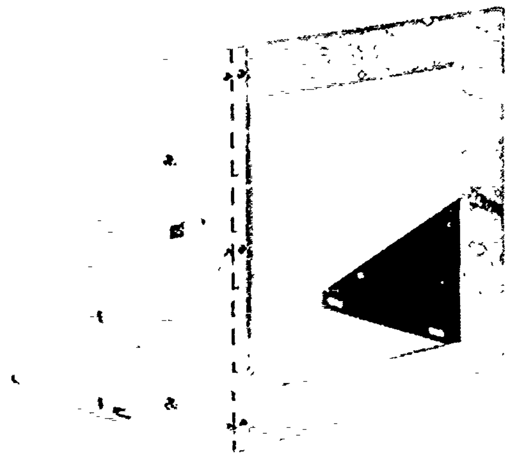


(c) LOUDSPE. KER ASSEMBLY (LSF 345-2-76)

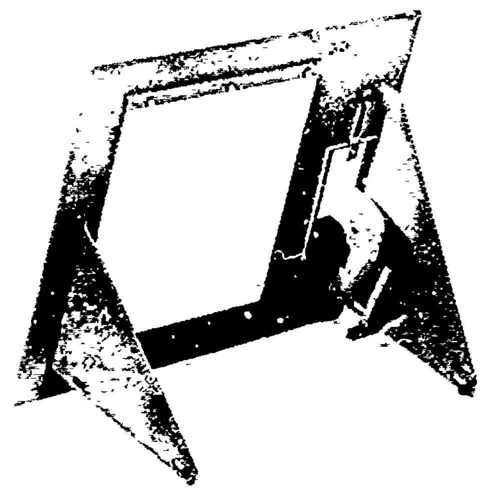


(d) ACCESSORIES (LSF 346-2-76)

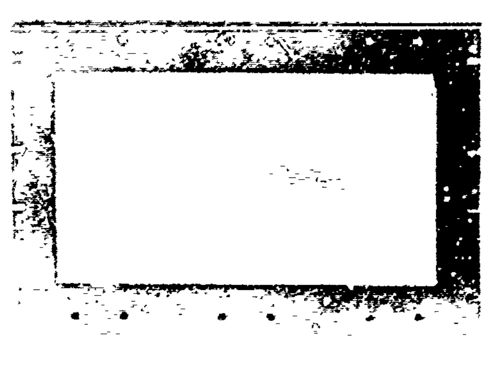
Figure 12. (Continued).



(a) REPERFORATOR BARRIER PANEL
FRONT VIEW (LSF 297-2-76)

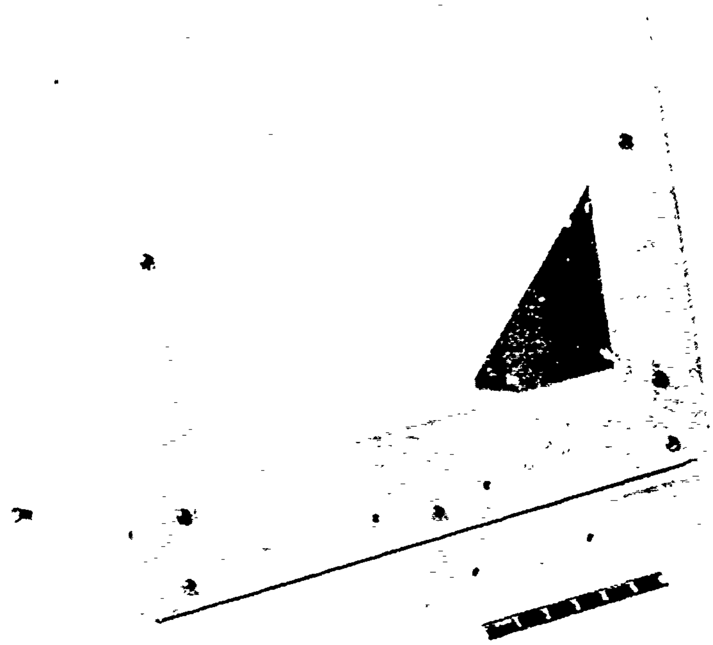


(b) REPERFORATOR BARRIER PANEL
REAR VIEW (LSF 296-2-76)

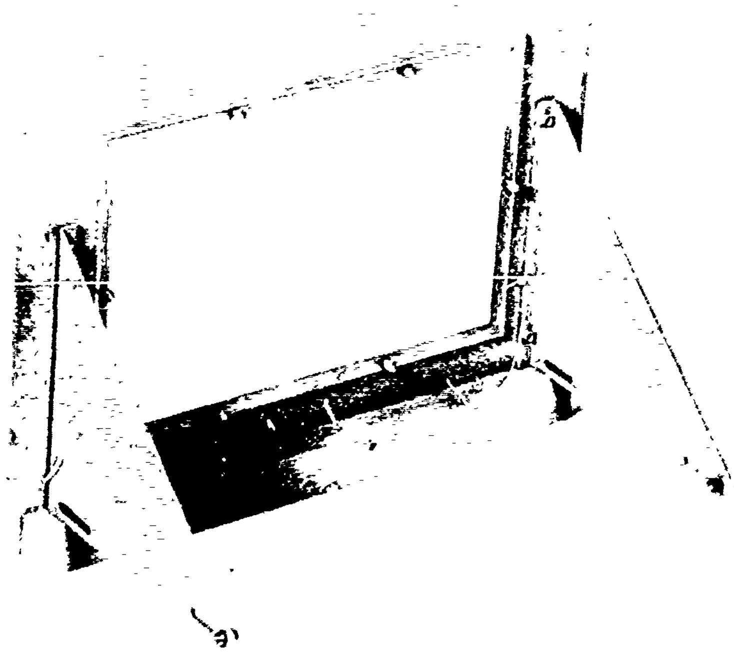


(c) VENTED POWER SUPPLY PANEL
(LSF 300-2-76)

Figure 13. Reperforator barrier panel and vented power supply panel.



(a) FRONT VIEW, WITH TELETYPE SHELF SPACER BAR (LSF 299-2-76)



(b) REAR VIEW (LSF 299-2-76)

Figure 14. Printer barrier panel.

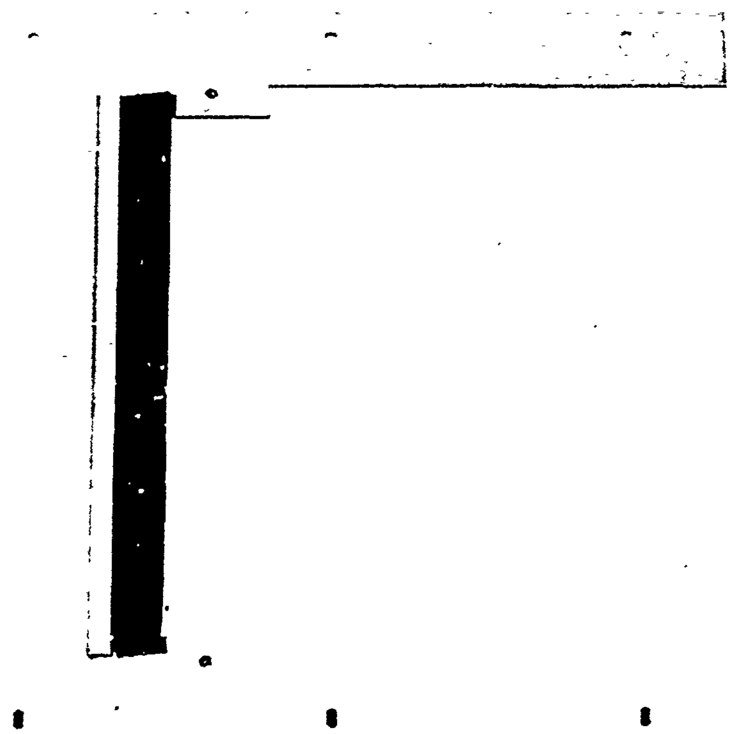


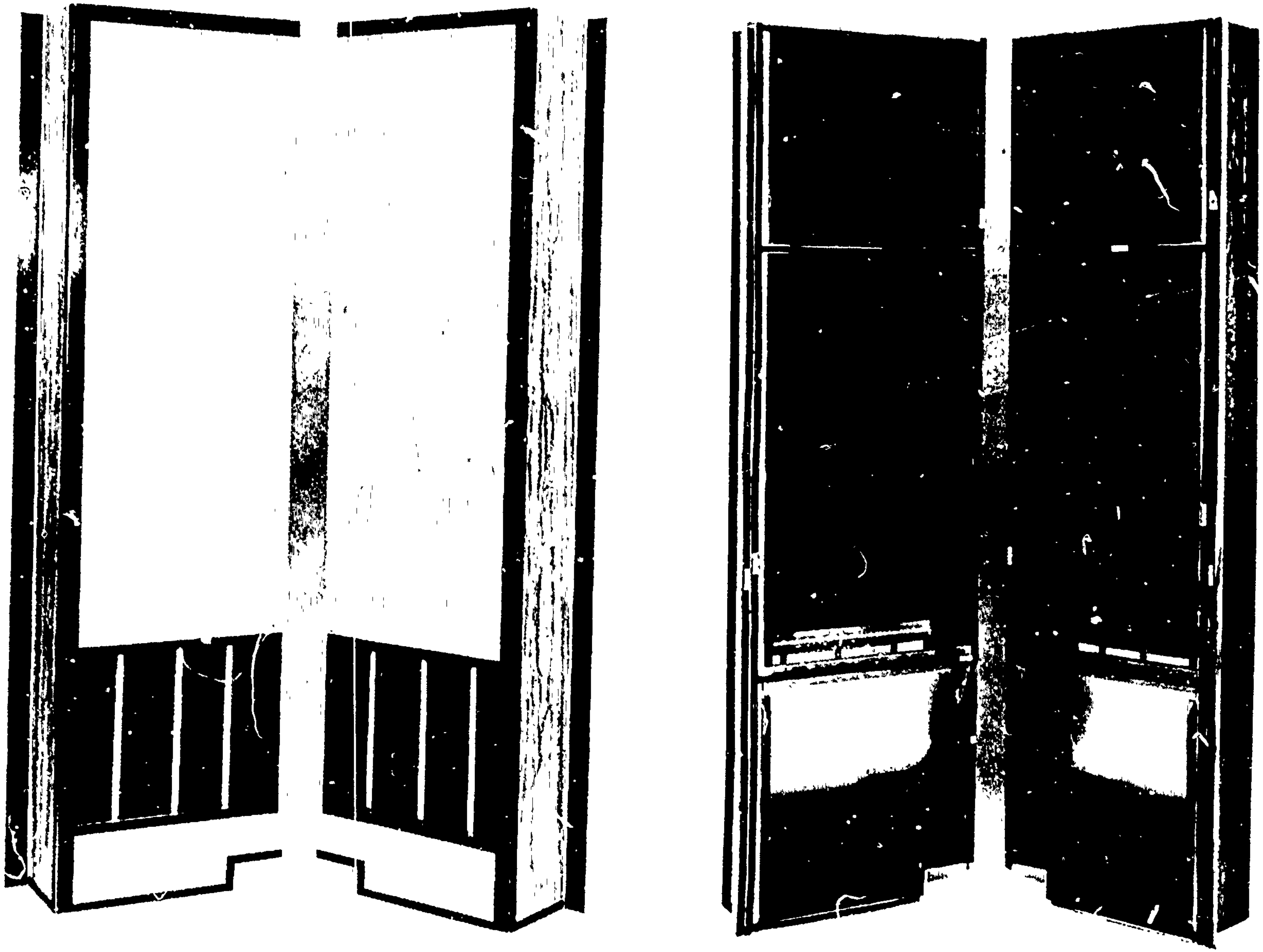
Figure 15. ARC-143 barrier panel (LSF 301-2-76).

## AIR CONDITIONER

The feasibility models of the air conditioner silencers attenuated only the sound exiting through the intakes, but an almost equivalent noise level was found to be produced by the complete wall that supports the air conditioner. Therefore, the prototype air conditioner silencer covers the entire 4-by-7-foot wall. The silencer is made in two sections which are bolted together before installation. As shown in figure 16, the silencer is lined with foam for sound absorption and gasketed for vibration isolation. The exterior was finished to match the existing wall decor. A washable foam filter fits into the opening near the bottom.

## ACOUSTIC CEILING

The feasibility model replacement foam, Conaflex A-FR-100, which was inserted above the perforated metal ceiling sections, performed as expected. This foam is also highly fire retardant; therefore, it met all the requirements for the prototype equipment and was used as part of it.



(a) FRONT VIEW (LSF 302-2-76)

(b) REAR VIEW (LSF 303-2-76)

Figure 16. Both halves of air conditioner silencer.

## PLANNED FOLLOW-UP

Since ASCOMM/TSC, NAF Sigonella, originated the messages that started the noise analysis, noise levels should be documented at that site before and after installation of the noise reduction equipment. NELC will be tasked to obtain the before and after operational equal-level noise contours of the ASCOMM/TSC, NAF, Sigonella, in July 1976, and will issue a report with these contours.